A Vinyl Streamer Tag for Shrimp (*Penaeus* spp.)[1]

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ABSTRACT

This paper describes a vinyl streamer tag for use on shrimp (*Penaeus* spp.). The tag is light and flexible, and has little if any effect on shrimp movement or behavior. In laboratory tests, the streamer was retained by the shrimp and caused no detectable tagging mortality, while considerable mortality occurred in shrimp tagged with a Petersen tag. In field tests over a 30-day period, there were limited dislocation and loss of streamer tags, but the dye used to color the vinyl material faded. Suggestions for modification of the streamer tag are made to alleviate these two problems. Mortality in shrimp tagged with the streamer did not differ significantly from that of untagged shrimp.

A variety of marks and tags have been used on shrimp (*Penaeus* spp.). The Petersen tag has been used by Lindner and Anderson (1956), Iversen and Idyll (1960), Iversen and Jones (1961), Iversen (1962), Allen and Costello (1963), Klima (1964), Welker et al. (1975) and others to mark shrimp. Shrimp also have been marked by injection with biological stains (Menzel 1955; Dawson 1957; Costello 1959; Klima 1965). Stained shrimp also have been marked secondarily with fluorescent pigments for identification of size classes (Klima 1965) and with internal polyvinyl tags for identification of individuals (Neal 1969).

Although each of these tags and marks has been effective to some degree, each has several important faults. The success of recent shrimp mark-recapture studies (Clark et al. 1974) appears to have varied greatly, due at least in part to variation in marking or tagging mortality and in retention of the mark or tag. In particular, the Petersen tag and the biological stain-internal tag combination appear to cause high mortality in shrimp under 75 mm total length (tip of rostrum to tip of telson; Welker et al. 1975), and retention of biological stains and fluorescent pigments is limited (Klima 1965).

This paper describes a vinyl streamer tag and laboratory and field tests of its use on shrimp (*Penaeus* spp.).

EXPERIMENTS

Streamer tags (Fig. 1) 2 mm wide and 150 mm long were cut from sheets of Clear Krene[4] vinyl 0.1 mm thick. A No. 7 Crewel stainless steel needle was cemented to one end of each streamer with industrial adhesive, and a colored tab of vinyl was cemented to the opposite end to enhance recognition of tagged animals. To mark a shrimp, the needle was inserted through the abdomen, the attached streamer then was drawn through the abdominal musculature until the lengths extending from each side of the shrimp were equal, then the needle was detached (Fig. 2). The tag was inserted through the articular membrane between the first and second abdominal segments to reduce interference with ecdysis.

Shrimp used in the three laboratory experiments described herein were collected by trawling in the Galveston Bay area. They were acclimated to laboratory conditions at least 24 hours before experiments. The first and third experiments were conducted in 76-liter aquaria provided with air-operated substrate filters, and substrate consisting of a 50-mm layer of crushed oyster shell covered by a 50-mm layer of medium-grade construction sand. The second experiment was conducted in two 1,500-liter tanks equipped with filters and substrates as above.

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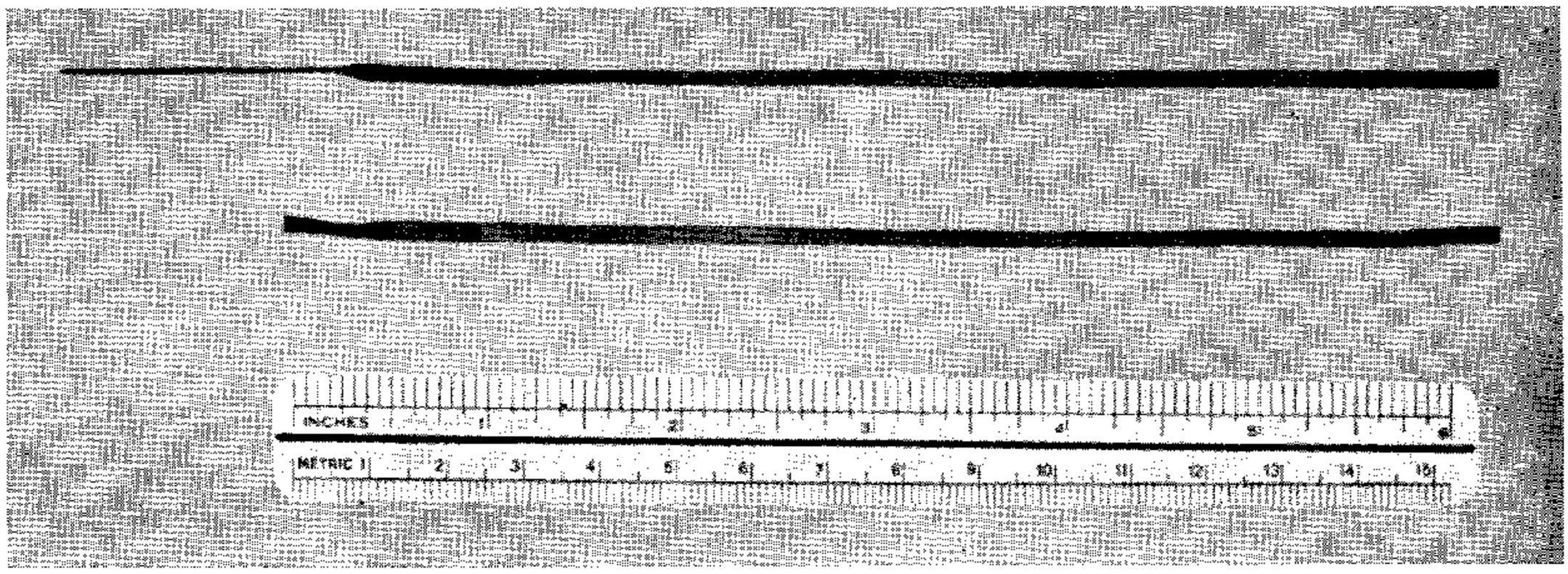

FIGURE 1.—*Vinyl streamer tag (as modified by red dye and number; see text).*

Experiment 1

The first experiment was conducted with pink shrimp (*Penaeus duorarum*) 94–108 mm total length. Six shrimp tagged with the streamer and six untagged (control) shrimp were assigned randomly to each of four aquaria. In 4 weeks, survival of the 24 tagged and 24 untagged shrimp was identical (69%). Two shrimp lost their tags and tag dislocation was evident in several others. We attributed tag dislocation and loss to the colored vinyl tab at the end of the streamer. This tab sometimes became caught in the substrate when the shrimp burrowed or emerged, and this apparently unseated the tag. To alleviate this problem, the colored tab was deleted. The improved streamers (Fig. 1) were dyed red and numbered sequentially by the manufacturer.[5]

Experiment 2

In the second experiment, 50 brown shrimp (*P. aztecus*) 83–103 mm in total length were tagged with improved streamers and put in

[5] Floy Tag and Manufacturing Company, Seattle, Washington.

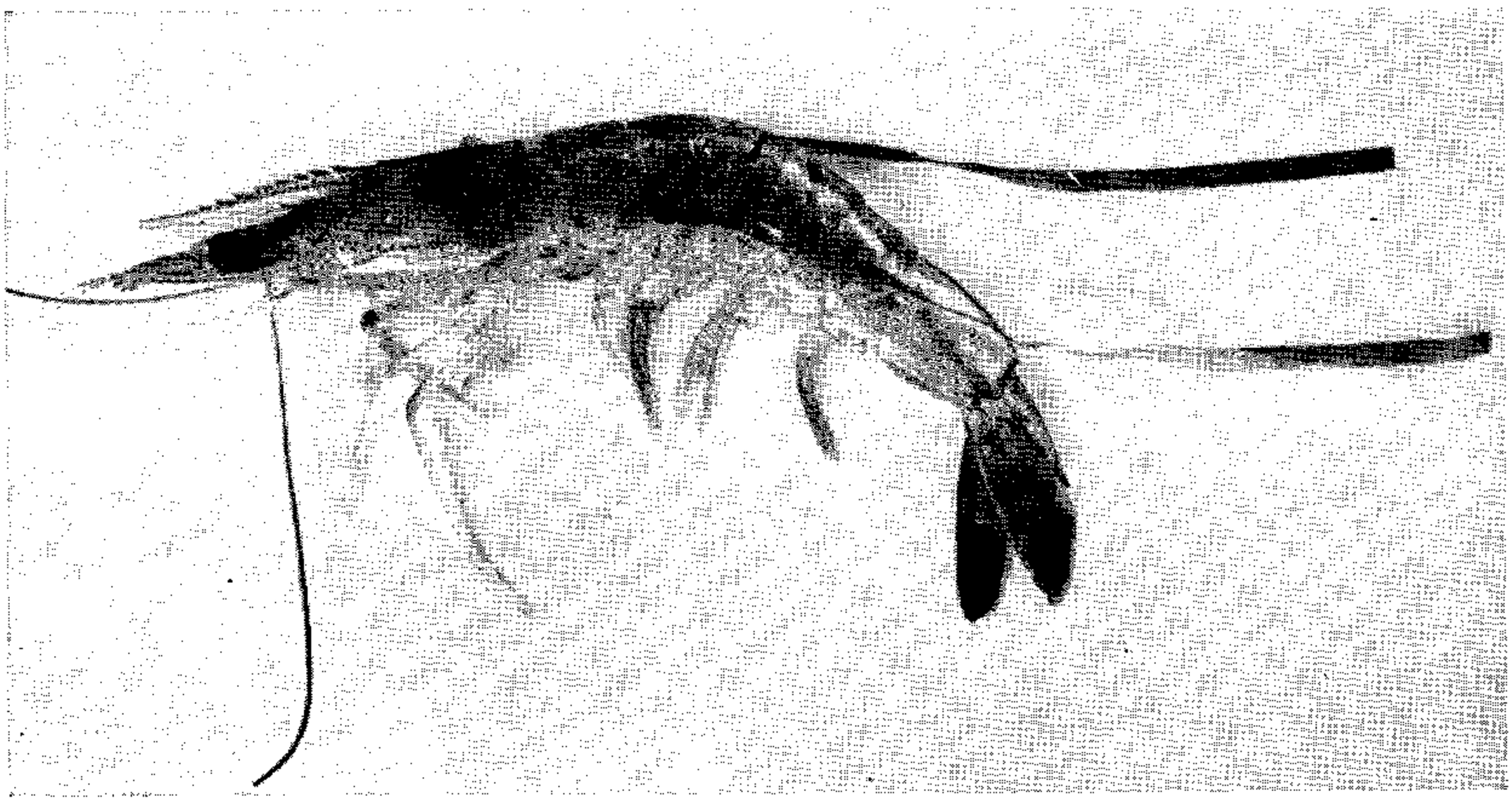

FIGURE 2.—*Shrimp marked with vinyl streamer tag (as modified by red dye and number; see text). Note point of insertion between first and second abdominal segments.*

TABLE 1.—*Number of white shrimp survivors*[a] *by treatment, aquarium group, and size*[b] *class (Experiment 3).*

Treatment, T	Aquarium group, A	Size class, S 60–69 mm	70–79 mm	80–89 mm	90–99 mm	Total
Control	1	4	3	4	3	14
	2	3	4	4	4	15
Streamer	1	3	3	3	4	13
	2	3	4	3	4	14
Petersen	1	2	0	0	0	2
	2	0	1	0	0	1
Totals by aquarium group	1	9	6	7	7	29
	2	6	9	7	8	30

[a] Four shrimp were used for each treatment and size class combination.
[b] Total length from tip of rostrum to tip of telson.

one tank; a second group of 25 shrimp was placed in the second tank as controls. Over a 30-day period, no tag dislocation or loss were observed, and survival of tagged (52%) and untagged (60%) shrimp was similar ($P > 0.05$) as indicated by a chi-square test.

Experiment 3

The third experiment was conducted to compare survival in shrimp tagged with the improved streamer with that of shrimp tagged with a Petersen tag (Welker et al. 1975), and to test the effect of shrimp size on survival. The Petersen tag consisted of two polyvinyl chloride discs 0.5 mm thick and 6.3 mm in diameter attached to the shrimp with a stainless steel pin trimmed and crimped on the end opposite the head. The pin was inserted through the articular membrane between the first and second abdominal segments. Eight aquaria were arranged into two groups of four aquaria each. White shrimp (*P. setiferus*) were separated into four total length classes: 60–69 mm, 70–79 mm, 80–89 mm, and 90–99 mm. Each size class was assigned randomly to a different aquarium within each group. Twelve shrimp selected randomly from each length class were assigned to the appropriate aquarium in each group. Of the 12 shrimp in each aquarium, four (randomly selected) were tagged with streamers, four (randomly selected) with the Petersen tag, and four (randomly selected) remained untagged (control). A 10% mixture of Aureomycin in white petroleum jelly was used on the tags to reduce mortality due to infection (as suggested by R. C. Benton, personal communication). The experiment lasted 30 days. Each day, the aquaria were checked, shrimp were fed, water temperature and salinity were recorded, and observations were made on behavior and mortality. Water temperature ranged from 26–29 C, and salinity was virtually constant near 16 parts per thousand during the experiment. Survival data are given in Table 1.

TABLE 2.—*Results of G tests of white shrimp survival data*[a] *(Experiment 3).*

Hypothesis tested[b]	Degrees of freedom	G
T × S independence	6	1.3253
T × A independence	2	0.1346
S × A independence	3	0.8957
T × S × A interaction	6	0.7894
T × S × A independence	17	3.1450

[a] One was added to each observation in Table 1 prior to G tests, because these tests are based on logarithms.
[b] T, treatments; S, size class; A, aquarium groups.

Neither size nor aquarium group had significant effects upon survival of white shrimp as shown by a G test[6] (Table 2). Therefore, data were summed over aquarium groups and size classes to give the following survivals by treatment: control, 91%; streamer, 84%; and Petersen, 9%. Chi-square tests showed that percent survival did not differ significantly between control and streamer-marked animals, but survival in both these groups was significantly ($P < 0.05$) higher than that in Petersen-tagged animals.

The pattern of mortality also differed between the streamer-tagged and Petersen-tagged shrimp. Shrimp tagged with streamers showed mortality only during the first 3 days after tagging, while mortality occurred throughout the experiment in shrimp tagged with Petersen tags.

Experiment 4

The fourth experiment was conducted in two 0.1-hectare earthen ponds used for shrimp culture by Texas A&M University on Houston

[6] A significance test of frequencies in multi-way classification; i.e., a test of independence (Sokal and Rohlf 1969, p. 559, etc.).

TABLE 3.—*Number of white shrimp survivors by treatment, pond, and condition of vinyl streamer tag (Experiment 4).*

Treatment, T	Pond, P	Condition of streamer, C			
		Normal	Dislocated	Missing	Total
Streamer	1	132	18	3	153
	2	127	14	9	150
Streamer and fluorescent pigment	1	56	11	14	81
	2	34	15	2	51
Totals by pond	1	188	29	17	234
	2	161	29	11	201

TABLE 5.—*Number of white shrimp survivors and losses by treatment and pond (Experiment 4).*

Treatment, T	Pond, P	Mortality, M		
		Survivors	Losses	Totals
Control	1	189	11	200
	2	110	90	200
Streamer	1	153	47	200
	2	150	50	200
Streamer and fluorescent pigment	1	81	19	100
	2	51	49	100
Totals by pond	1	423	77	500
	2	311	189	500

Lighting and Power Company property near Baytown, Texas. These ponds were 0.6 m deep at one end and 1.2 m deep at the opposite end. On May 31, 1974, white shrimp were purchased from a local bait dealer and transported to the pond area. They were measured and separated into two size classes, 70–79 mm and 80–89 mm total length. The larger shrimp were assigned to Pond 1 and the smaller to Pond 2. Into each pond were put 200 shrimp tagged with the streamer, 100 tagged with the streamer and marked with fluorescent pigment, and 200 untagged-unmarked (control). Aureomycin mixture was used on the tags as in Experiment 3. The ponds were drained 30 days later. Most of the shrimp in the ponds were caught with a net placed over the outflow pipe, and those remaining after the ponds were drained were picked up by hand. All were counted and identified by treatment (control, streamer, or streamer-fluorescent pigment), and not more than 100 from each treatment were measured.

There was a possibility of misclassification by treatment in that some shrimp that lost the streamer may have been classified as controls. However, we were able to recognize shrimp that had been tagged, although the tag was missing (Table 3), by closely examining the abdominal area where tags had been inserted. It has been our experience in other tagging studies that the fluorescent pigment mark persists beyond 30 days, so shrimp tagged with streamer and marked with fluorescent pigment could be identified as such, although they may have lost the streamer.

Tag retention is portrayed by data in Table 3 in which the numbers of surviving white shrimp are classified by treatment (streamer vs. streamer-fluorescent pigment) and condition of streamer (normal, dislocated, or missing). *G* tests of the data (Table 4) indicated significant dependence among treatments, ponds, and condition in their influence on shrimp survival. Most (80%) of the animals identified as having been tagged retained tags in the normal position, fewer (13%) had dislocated tags, and still fewer (7%) had lost the tag.

TABLE 4.—*Results of G tests of white shrimp data on condition of vinyl streamer tag (Experiment 4). (*Indicates significance at the 95% level of confidence.)*

Hypothesis tested[a]	Degrees of freedom	*G*
T × P independence	1	4.4020*
T × C independence	2	17.5056*
C × P independence	2	0.8808
T × C × P interaction	2	12.1233*
T × C × P independence	7	34.9116*

[a] T, Treatments; P, Ponds; C, Condition of streamer.

TABLE 6.—*Results of G tests of white shrimp survival and loss data (Experiment 4). (*Indicates significance at the 95% level of confidence.)*

Hypothesis tested[a]	Degrees of freedom	*G*
T × M independence	2	6.8574*
Tagged vs. control	(1)	0.6247
Streamer vs. streamer and fluorescent pigment	(1)	6.2327*
T × P independence	2	–0.0001
P × M independence	1	65.8175*
T × P × M interaction	2	46.4889*
T × P × M independence	7	119.1637*

[a] T, Treatments; P, Ponds; M, Mortality.

TABLE 7.—*Size-frequency distributions of white shrimp survivors[a] by treatment and pond (Experiment 4).*

Treatment, T	Pond, P	Size[b] class (S) 95–99 mm	100–104 mm	105–109 mm	110–114 mm	115–119 mm	120–124 mm	125–129 mm	130–134 mm	Total
Control	1	0	0	7	25	36	22	10	0	100
	2	0	4	19	22	34	12	2	0	93
Streamer	1	0	0	5	24	36	25	9	1	100
	2	1	1	21	28	32	13	4	0	100
Streamer and fluorescent pigment	1	0	1	0	19	27	27	6	1	81
	2	0	1	6	13	23	7	1	0	51
Totals by pond	1	0	1	12	68	99	74	25	2	281
	2	1	6	46	63	89	32	7	0	244

[a] When there were more than 100 survivors in a treatment, not more than 100 specimens were measured. Otherwise all survivors in a treatment were measured.
[b] Total length from tip of rostrum to tip of telson.

Table 5 gives survivors and losses by treatment and pond for the fourth experiment. *G* tests (Table 6) detected a significant dependence among treatments, ponds, and mortality. Shrimp in Pond 2, originally 70–79 mm total length, exhibited higher mortality than those, 80–89 mm, in Pond 1. Mortality in tagged shrimp did not differ significantly from that of the controls (Table 6). Survival was significantly lower (66%) in animals tagged with streamer and marked with pigment than in those with streamer only (76%).

Size-frequency distribution of survivors (Table 7) was not significantly dependent upon treatment (Table 8), but was dependent upon pond, a carry-over from the initial size difference in shrimp assigned to the two ponds. Thus, the tags had no apparent effect on shrimp growth. Mean total lengths of 50 specimens at the time of tagging were 83 mm in Pond 1 and 74 mm in Pond 2. Mean total lengths at the end of the experiment were 116 mm (281 specimens) in Pond 1 and 115 mm (244 specimens) in Pond 2.

TABLE 8.—*Results of G tests of white shrimp size-frequency data (Experiment 4).*
*(*Indicates significance at the 95% level of confidence.)*

Hypothesis tested[a]	Degrees of freedom	*G*
T × P independence	2	4.5223
T × S independence	14	20.1808
S × P independence	7	55.3487*
T × S × P interaction	14	3.8743
T × S × P independence	37	83.9261*

[a] T, Treatments; P, Ponds; S, Size classes.

DISCUSSION

Streamer tags were superior to Petersen tags in our laboratory experiments for two main reasons. First, shrimp were tagged more easily and rapidly with the streamer than with the Petersen tag, and they appeared to have been less traumatized. Tagging time with the streamer might be further shortened by use of slender surgical needles with the eyes cut open on one side (Allen and Costello 1963). Shrimp tagged with the streamer regained equilibrium and began swimming actively upon return to aquaria after tagging, whereas those tagged with Petersen tags were lethargic for 3 to 5 minutes after marking. Second, the streamer tag used in these experiments is lighter (0.05 g) and more flexible than the Petersen tag (0.14 g). A 6-mm excess length was left on the Petersen tag pins (as would be the case to allow for shrimp growth in long-term experiments). The pin often shifted to one side, and the resulting imbalance impaired shrimp swimming and burrowing activities. Intermittent dislocation of the pin was also observed on occasion and this may have interfered with wound repair, thus contributing to continued mortality. Lindner and Anderson (1956) and Neal (1969) recognized that high mortality was associated with use of the Petersen tag on shrimp. Some tag dislocation occurred, but loss of balance was not observed in shrimp tagged with the streamer. These shrimp exhibited no difficulty in swimming or burrowing.

The field test of the streamer tag in ponds showed that tag retention was good, that

shrimp growth was not impaired, and that mortality of tagged shrimp did not differ significantly from that of untagged controls. Dislocation and loss of the streamer tag might be averted by making the tag narrower near the center than at the outer portions. The red dye faded during the experiment. This would reduce ease of recognition of tags in large-scale experiments in which fishermen would be required to recognize marked animals. It also is possible that some of the dye leaching from the vinyl is absorbed by the shrimp and, while sublethal, it may still be toxic to the shrimp or to animals consuming the shrimp. Colorfast materials should be tested in this regard. Studies also are needed to determine whether or not predation is increased by presence of the streamer (Costello and Allen, 1962). However, we believe that the streamer tag has potential for use on juvenile and larger shrimp in long-term mark-recapture studies.

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LITERATURE CITED

ALLEN, D. M., AND T. J. COSTELLO. 1963. The use of Atkins-type tags on shrimp. Pages 88–89 *in* Fishery Research Biological Laboratory, Galveston, Fiscal Year 1962. U.S. Fish Wildl. Serv. Circ. 161.

CLARK, S. H., D. A. EMILIANI, AND R. A. NEAL. 1974. Release and recovery data from brown and white shrimp mark-recapture studies in the northern Gulf of Mexico. National Marine Fisheries Service, Data Report No. 85. 152 pp.

COSTELLO, T. J. 1959. Marking shrimp with biological stains. Gulf Caribb. Fish. Inst., Univ. Miami, Proc. 11: 1–6.

———, AND D. M. ALLEN. 1962. Survival of stained, tagged and unmarked shrimp in the presence of predators. Gulf Caribb. Fish. Inst., Univ. Miami, Proc. 14: 16–20.

DAWSON, C. E. 1957. Studies on the marking of commercial shrimp with biological stains. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. No. 231. 24 pp.

IVERSEN, E. S. 1962. Estimating a population of shrimp by use of catch per effort and tagging data. Bull. Mar. Sci. Gulf Caribb. 23: 350–398.

———, AND C. P. IDYLL. 1960. Aspects of the biology of the Tortugas pink shrimp, *Penaeus duorarum*. Trans. Am. Fish. Soc. 89: 1–8.

———, AND A. C. JONES. 1961. Growth and migration of the Tortugas pink shrimp, *Penaeus duorarum*, and changes in the catch per unit effort of the fishery. Fla. State Board Conserv. Tech. Ser. 34. 30 pp.

KLIMA, E. F. 1964. Mark-recapture experiments with brown and white shrimp in the northern Gulf of Mexico. Gulf Caribb. Fish. Inst., Univ. Miami, Proc. 16: 52–64.

———. 1965. Evaluation of biological stains, inks, and fluorescent pigments as marks for shrimp. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. No. 511. 8 pp.

LINDNER, M. J., AND W. W. ANDERSON. 1956. Growth, migrations, spawning and size distribution of shrimp *Penaeus setiferus*. U.S. Fish Wildl. Serv. Fish. Bull. 106: 555–645.

MENZEL, R. W. 1955. Marking of shrimp. Science 121: 446.

NEAL, R. A. 1969. Methods of marking shrimp. FAO (F.A.O.U.N.) Fish. Rep. 57: 1149–1165.

SOKAL, R. R., AND F. J. ROHLF. 1969. Biometry. W. H. Freeman and Co., San Francisco. 776 pp.

WELKER, B. D., S. H. CLARK, C. T. FONTAINE, AND R. C. BENTON. 1975. A comparison of Petersen tags and biological stains used with internal tags as marks for shrimp. Gulf Res. Rep. 5(1): 22–26.